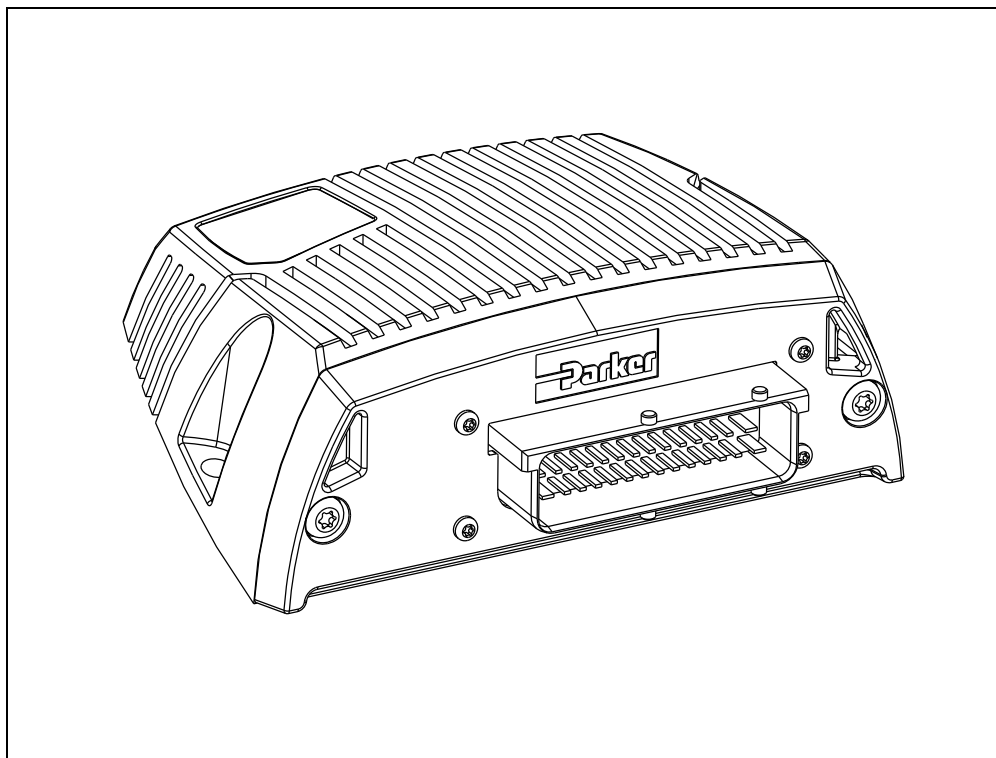


IQAN-MC2

Instruction book

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ENGINEERING YOUR SUCCESS

1	Introduction	1
	Warnings	1
	Overview of relevant documentation	2
2	Precautions	3
	Read This	3
3	Product description	5
	IQAN-MC2	5
4	Safety	8
	Internal diagnostics	8
	CAN-bus interruption	8
	Current check	8
	Emergency stop	8
5	Mounting	9
	Mounting the module	9
6	Installation	10
	Supply voltage	12
	Addressing/terminating	13
	Diagnostic interfaces	14
	Reference voltage, VREF	16
	Voltage inputs	17
	Digital inputs	20
	Frequency inputs	22
	Proportional outputs	23
	Connecting loads to proportional outputs	23
	Digital outputs	24
	Low-side digital outputs	25
7	Start-up	26
	Start-up procedures	26
8	System Diagnostics	27
	Safe mode	28
	Appendix A	29
	IQAN-MC2 Technical Overview	29
	Appendix B	34
	Error codes, messages and actions	34
	Appendix C	35
	Dimensioning of the IQAN module	35

1 Introduction

These instructions are to be used as a reference tool for the vehicle manufacturer's design, production, and service personnel.

The user of these instructions should have basic knowledge in the handling of electronic equipment.

Warnings

Sections marked with a symbol in the left margin, must be read and understood by everyone using the system, carrying out service work, or making changes to hardware and software.

The different symbols used in this manual are defined below.



WARNING

Sections labeled *WARNING* with a caution symbol in the left margin, indicate that a hazardous situation exists. We use warnings, marked with the warning symbol, in two ways.

- As a strong recommendation about work practices when using the product in the machine (e.g. routines when updating an application). This use is common to the term 'hazardous situation', that a person is exposed to a hazard.
- As a way of pointing out important information for the machine designer that in some way relates to safety. This includes the design of the physical machine, and also the application program being developed for the control system.

Not all document sections that contain information about safety are marked with a warning symbol (there would be warnings everywhere). Failure to comply with the recommendations can cause unintentional, and unexpected behavior of the control system. This can potentially cause death, serious injury or property damage.



NOTICE

Sections labeled *NOTICE* with a notice symbol in the left margin, indicate there is important information about the product. Ignoring this could result in less than optimal performance, or damage to the product.

Contact the manufacturer if there is anything you are not sure about or if you have any questions regarding the product and its handling or maintenance.

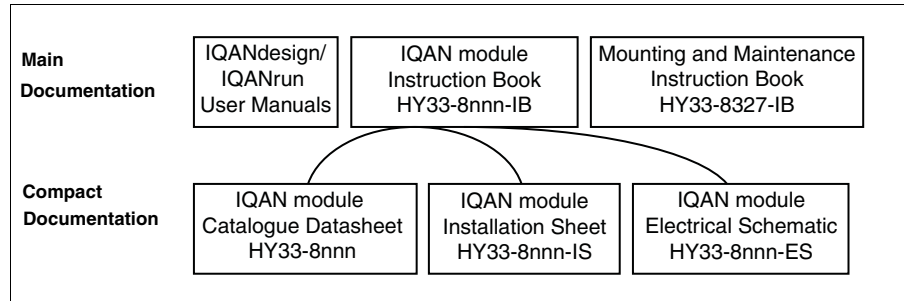
The term "manufacturer" refers to Parker Hannifin Corporation.

Overview of relevant documentation

The following publications are relevant for users of this product.

The main documentation contains information that is not found elsewhere.

The additional documentation contains product information in a compact format, for details on the information found in those documents, consult this manual.



The IQAN module documentation system.

2 Precautions

Work on the hydraulics control electronics may only be carried out by trained personnel who are well-acquainted with the control system, the machine and its safety regulations.

**WARNING**

Make sure that you have sufficient knowledge before designing, modifying or servicing the control system.

Read the relevant sections of this document before conducting any work on the control system.

**WARNING**

This product is not field repairable.

**NOTICE**

As much as possible of the welding work on the chassis should be done before the installation of the system. If welding has to be done afterwards, the electrical connections on the system must be disconnected from other equipment. The negative cable must always be disconnected from the battery before disconnecting the positive cable. The ground wire of the welder shall be positioned as close as possible to the place of the welding. The cables on the welding unit shall never be placed near the electrical wires of the control system.

Read This

Design of control system

**WARNING**

Risk of injury may be introduced by design of control system!

This product is designed to control hydraulic outputs. The control application must be designed using basic safety principles so that unintentional movement is avoided.

The machine must be equipped with an emergency stop that stops all movement. Please refer to section "Supply voltage".

Before you start

Read this document.

Read the IQANdesign software user manual section on 'application safety'.

Start-up, maintenance, and diagnostics

For all personnel carrying out installation, commissioning, maintenance or troubleshooting.

**WARNING**

Work on the hydraulics control electronics may only be carried out by trained personnel who are well-acquainted with the control system, the machine and its safety regulations.

Before you start,

Read section "Start-up".

Additional information for service

Mounting and maintenance instruction book.

Additional information for diagnosing the system

Read section "System diagnostics", and see "Appendix B", in this document.

Use the IQANrun software user manual as a reference.

3 Product description

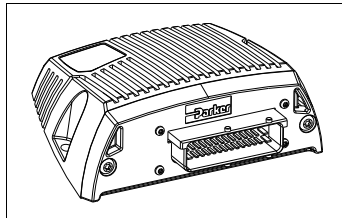
IQAN-MC2

The IQAN-MC2 is designed for controlling hydraulic systems in vehicles and machinery, using 12/24 Vdc power supply.

IQAN-MC2 is a master unit capable of running applications created by IQANdesign. The MC2 has local I/O for input/output use and has two CAN busses that support ICP (IQAN CAN Protocol), SAE J1939 and Generic CAN.

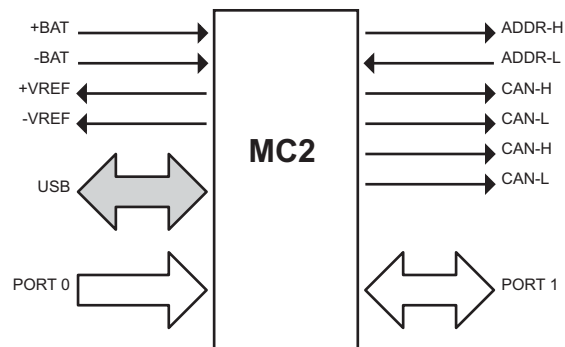
By supporting SAE J1939 and Generic CAN the MC2 can act as a sub-master when there is a need of higher performance in a sub-circuit or when there is an OEM supplied overall machine master.

This product is designed for the outdoor environment and comes with an IP6K9K protection for applications where high-pressure water and steam jet cleaning is used.



The IQAN-MC2 module.

I/O overview



Inputs

The IQAN-MC2 module has five (5) *voltage inputs* VIN-A thru VIN-E for connection of 0-5 Vdc signals. The inputs are multi-purpose and for flexibility may be configured in other ways. The input pins VIN-A and VIN-E can be configured as *on/off inputs* for switches or as *frequency inputs* for measuring frequency. *Voltage inputs, on/off inputs and frequency inputs* share positions, see list.

(5) Voltage inputs VIN-A thru VIN-E

or

(5) Frequency inputs FIN-A thru FIN-E use positions VIN-A thru VIN-E.

or

(5) Digital inputs DIN-A thru DIN-E use positions VIN-A thru VIN-E.

Proportional outputs

The MC2 module has eight (8) double *proportional outputs* for controlling proportional valves. These outputs can control eight bi-directional valve sections or eight single solenoid devices (ie. proportional cartridge valves). The proportional outputs can be used in two different modes. Either *Current mode* (current closed loop) or *PWM mode* (voltage open loop) signals can be selected and the parameters configured using IQAN software.

For flexibility these outputs may also be configured as up to eight (8) *on/off outputs* and up to eight (8) *on/off inputs or voltage inputs*. Additional functionality for these positions is as up to sixteen (16) *low-side on/off outputs*. The proportional outputs, on/off outputs, on/off or voltage inputs and low-side on/off outputs share positions, see below.

(8) double proportional outputs COUT-A thru COUT-H

or

(8) double proportional outputs PWMOUT-A thru PWMOUT-H

or

(8) on/off outputs DOUT-A thru DOUT-H.

Each pair of return pins may then be used as:

(2) low-side digital output switches (16) total, DOUT(LS)-I thru DOUT(LS)-X.
It is recommended to use one or more of DOUT-A thru DOUT-H as source if used in this manner, for safety.

The pairs of return pins associated with DOUT-E thru DOUT-H may also be used as:

(2) on/off inputs, (8) total, DIN-F thru DIN-M.
 (2) voltage inputs, (8) total, VIN-F thru VIN-M.

In order to increase the performance of the proportional outputs when controlling proportional valves, the *dither frequency* can be adjusted.

CAN related functions

The IQAN-MC2 uses a CAN-bus (CAN = Controller Area Network) to communicate with IQAN expansion modules and other systems. The CAN-bus is a robust communication protocol that is widely used and well proven within the automotive industry.

The unit has two (2) CAN buses, CAN-A and CAN-B. The buses may be configured using IQAN software to be ICP (ICP = IQAN CAN Protocol), SAE J1939 or Generic user defined CAN protocol (e.g. CANopen).

Communication

The communication interfaces are used for uploading/downloading applications or diagnostics and typically are connected to a computer.

CAN

The IQAN-MC2 has 2 CAN buses. Either of the CAN buses may be used for communication and diagnostics. A CAN communication card is required to be installed in your PC to use this feature.

USB

The IQAN-MC2 has a USB1.1 (device only) connection in connector C1, for maximum voltage on USB pins, see Appendix A.

4 Safety

Internal diagnostics

The module performs a number of self-checks that improve safety. Checks include monitoring of voltage supplies, checksums on memory and a watchdog that monitors software execution. The module is using a real time operating system which supervises software execution.

If a critical error is detected, the module is stopped, with CAN-bus and outputs off.

CAN-bus interruption

The IQAN modules communicate on a CAN-bus. Both the master module and expansion modules check for any interruptions in CAN-bus communication. If an error occurs the master will use zero or an application defined error value for the module inputs, and the module outputs will be off.

The error will be presented on the master/display module, if there is one, and with a related blink code on the IQAN module status LEDs.

Current check

For the proportional outputs when used in current mode, a current check is performed. If an error is detected, this will be indicated on the master module, and the output will shut off.

The module can detect open-circuit, short-circuit to +BAT/-BAT or short-circuit to other proportional output and return pins.

Emergency stop



WARNING

Risk of injury!

The emergency stop must disconnect the power supply to the module; do not connect the emergency stop as a signal input only.

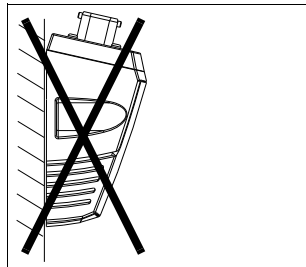
The emergency stop must be installed so that the risk of reverse feed of the module is avoided, see section "Supply voltage".

5 Mounting

Mounting the module

The IQAN module should be mounted according to the following instructions:

- Locate the module eliminating the risk for the cabling to be folded, crushed or damaged in any way. Ensure the cabling cannot pull, twist or induce side load on the connector.
- Locate the module so that severe physical impact is avoided, e.g impact from falling objects or the module being used as a step.
- Locate the module so that air can circulate to eliminate excess heat. Ensure that no external heat, e.g. from the engine or heater, is transferred to the module.
- Locate the module to protect it from high pressure washing or similar.
- Locate the module so that the cable connector is facing down.
- Locate the module so that the LEDs are visible.



Non approved placing.



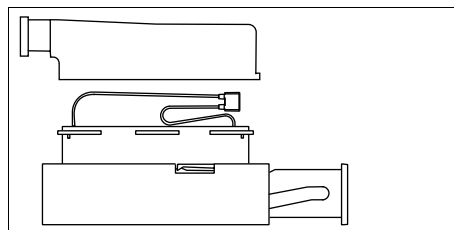
NOTICE

The IQAN module must not be placed in any marine related or similar continuously damp, salt-spray environment without external protection.

Assembling of the ID-Tag

The ID-Tag will be placed in the connector in order to address/ terminate the module. For IQAN master modules, the use of an ID-tag is application dependant. All IQAN expansion modules require an ID-tag, ref section "Addressing/terminating".

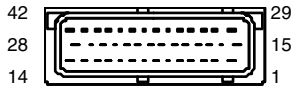
The ID-Tag will be mounted under the connector casing. Bend the ID-Tag's wires toward the opposite side of where the other wires enter the connector.



Assembling of the Id-Tag.

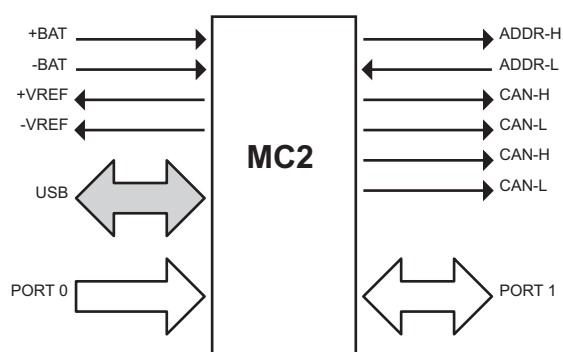
6 Installation

Connector C1

Connector kit	Parker no. 5031063	
Housing	Amp no. 1-963226-1	
Casing	Amp no. 0-965643-1	
Plane sealing, 42 p	Amp no. 963225-1	
Pin types*	Amp no. 963711-2 (MT)	
Cables	0,75-1,0 mm ² (MT)	Amp no. 929938-1 (JPT)
Seals	Amp no. 963530-1 (MT)	1,5-2,5 mm ² (JPT)
Plugs (empty pos.)	Amp no. 963531-1 (MT)	Amp no. 828905-1 (JPT)
IQAN crimping tool references	Blue handle, pos. A use blue extraction tool	Red handle, pos. B use yellow extraction tool
IQAN tool kit	Parker no. 5031061	

*= The connector contains two types of terminals; MT (Micro Timer) and JPT (Junior Power Timer).

Connector pin assignments



Symbol	Pin No.	In Out	Function
+BAT	28	-	Power supply
-BAT	15	-	Power supply
+RTC	6	-	Power supply for RTC.
+VREF	42	-	Voltage reference for external sensors. Sourcing +5V.
-VREF	29	-	Voltage reference for external sensors. Return (0V).
ADDR-H	1	-	IdTag interface. High side to address tag. Sourcing +5V.
ADDR-L	14	-	IdTag interface. Low side to address tag. Return signal.

Symbol	Pin No.	In Out	Function				
CAN-A-H	27	-	CAN high voltage bus line, will be HIGH in dominant state.				
CAN-A-L	41	-	CAN low voltage bus line, will be LOW in dominant state.				
CAN-B-H	26	-	CAN high voltage bus line, will be HIGH in dominant state.				
CAN-B-L	40	-	CAN low voltage bus line, will be LOW in dominant state.				
USB-D+	12	-	USB high voltage bus line. USB shield and gnd connects to -VREF or -BAT.				
USB-D-	13	-	USB low voltage bus line. USB shield and gnd connects to -VREF or -BAT.				
P0			P0 is an 5pin input port with alternative functions.				
			VIN	DIN	FIN		
P0.0	20	I	VIN-A	DIN-A	FIN-A		
P0.1	21	I	VIN-B	DIN-B	FIN-B		
P0.2	34	I	VIN-C	DIN-C	FIN-C		
P0.3	35	I	VIN-D	DIN-D	FIN-D		
P0.4	7	I	VIN-E	DIN-E	FIN-E		
P1			P1 is an 24pin input/output port with alternative functions.				
			COUT	PWMOUT	DOUT	VIN	DIN
P1.0	2	O	COUT-A	PWMOUT-A	DOUT-A	-	-
P1.1	16	O/I	RET-A+	RET-A+	DOUT(LS)-I	-	-
P1.2	30	O/I	RET-A-	RET-A-	DOUT(LS)-J	-	-
P1.3	3	O	COUT-B	PWMOUT-B	DOUT-B	-	-
P1.4	17	O/I	RET-B+	RET-B+	DOUT(LS)-K	-	-
P1.5	31	O/I	RET-B-	RET-B-	DOUT(LS)-L	-	-
P1.6	4	O	COUT-C	PWMOUT-C	DOUT-C	-	-
P1.7	18	O/I	RET-C+	RET-C+	DOUT(LS)-M	-	-
P1.8	32	O/I	RET-C-	RET-C-	DOUT(LS)-N	-	-
P1.9	5	O	COUT-D	PWMOUT-D	DOUT-D	-	-
P1.10	19	O/I	RET-D+	RET-D+	DOUT(LS)-O	-	-
P1.11	33	O/I	RET-D-	RET-D-	DOUT(LS)-P	-	-
P1.12	8	O	COUT-E	PWMOUT-E	DOUT-E	-	-
P1.13	22	O/I	RET-E+	RET-E+	DOUT(LS)-Q	VIN-F	DIN-F
P1.14	36	O/I	RET-E-	RET-E-	DOUT(LS)-R	VIN-G	DIN-G
P1.15	9	O	COUT-F	PWMOUT-F	DOUT-F	-	-
P1.16	23	O/I	RET-F+	RET-F+	DOUT(LS)-S	VIN-H	DIN-H
P1.17	37	O/I	RET-F-	RET-F-	DOUT(LS)-T	VIN-I	DIN-I
P1.18	10	O	COUT-G	PWMOUT-G	DOUT-G	-	-
P1.19	24	O/I	RET-G+	RET-G+	DOUT(LS)-U	VIN-J	DIN-J
P1.20	38	O/I	RET-G-	RET-G-	DOUT(LS)-V	VIN-K	DIN-K
P1.21	11	O	COUT-H	PWMOUT-H	DOUT-H	-	-
P1.22	25	O/I	RET-H+	RET-H+	DOUT(LS)-W	VIN-L	DIN-L
P1.23	39	O/I	RET-H-	RET-H-	DOUT(LS)-X	VIN-M	DIN-M
Note: If a COUT or PWMOUT block (COUT-x/PWMOUT-x, RET-x+, RET-x-) is used, all three pins are configured as COUT (or PWMOUT).							
Note: VIN-F to VIN-M (or DIN-F to DIN-M) can only be configured in pairs. Each pair can only be either inputs (VIN, DIN), or outputs (DOUT-LS)							
VIN-F to VIN-M (or DIN-F to DIN-M) are equipped with clamping diodes, risk for 'backending'. See section "Connecting switches to digital inputs".							

Shaded positions are Junior Power Timer pins. Unshaded positions are Micro Timer pins. See above for wire, seal, pin number and crimping tool information. The IQAN tool kit is found in the 'IQAN accessories' datasheet.

Supply voltage

Before any installation of the IQAN system can take place, make sure the ignition lock is turned off and the battery is disconnected.

Emergency stop

Make sure an *Emergency Stop* disconnecting the power supply, is easily accessible at any time. The figure below shows how to connect the emergency stop.

Connecting of Supply Voltage

The supply voltage, should be within the operating interval, see Appendix A. Connect the supply voltage to +BAT and -BAT. Protect the module by using a fuse. For requisite fuse level, see Appendix A.

RTC supply

IQAN master modules have a clock that is used for date/time stamping when logging data. The *real time clock*, +RTC, requires a separate positive power connection. Connect the supply voltage to +RTC through a 1.5K ohm resistor. The resistor should be as close to the battery as possible for safety. Expansion modules do not have +RTC.



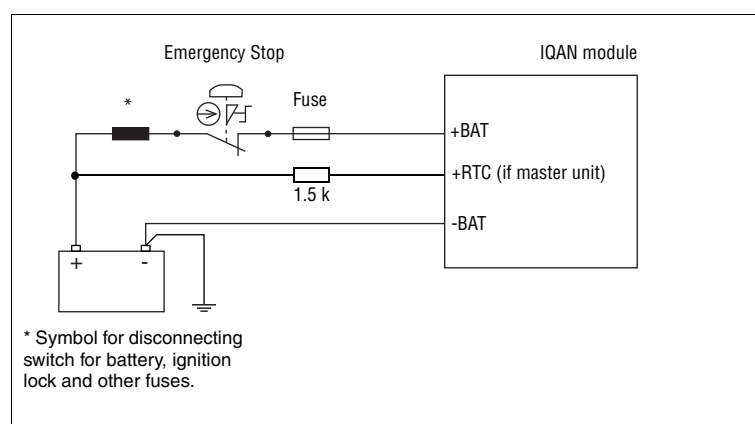
WARNING

Risk of injury!

To reduce the risk for uncontrolled supply of an IQAN master module, i.e., a short circuit between the +RTC cable and +BAT, a resistor must be connected between the battery and the +RTC input. This is important as this line is not controlled by an emergency stop.

The resistor should be placed close to the battery, as the 'protected' part is the cable between the resistor and the unit.

This will prevent the +RTC wire from powering up the unit if shorted to +BAT. The same possibility exists from a short to CRET wires when they are used as digital inputs; refer to section "DIN that share pin with RET".



Connecting the emergency stop and voltage supply.



NOTICE

Do not use the chassis as the negative terminal.

Polarity reversal

The module is protected against power supply polarity reversal and over-voltage, provided an external fuse is being used.

If this fuse is not used, polarity reversal can damage the unit.

Addressing/terminating

IQAN-MC2 use of an ID-Tag

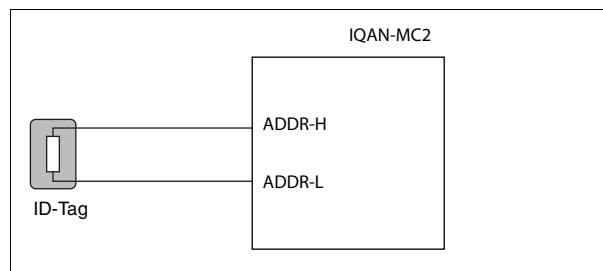
In IQANdesign 3.0 and higher software, more than one IQAN master module can be used together in a multi-master system. The master modules are each given a unique address by using an ID-Tag. The value of the ID-Tag identifies the master and will enable a single project application to be loaded into more than one master module over the CAN bus. The functionality needed for each master is loaded based on the ID-tag address. By default, if no ID-tag is installed, the MC2 will be address 0.

Identification of an IQAN-MC2 by address

For normal operation of an IQAN-MC2 in a single master system, the ID-Tag is not used. It is only needed when the IQAN-MC2 is used in a multi-master system, and an address other than '0' is needed. The connection of an ID-Tag between ADDR-H and ADDR-L will assign an address to the IQAN-MC2 master module. The desired functionality based on address is built into the project file using IQANdesign software. For more information, please refer to the IQANdesign user manual.

It is the combination of *address* and *type* that gives each master module a unique identification. The maximum number of MC2 addresses is 8, denoted as addresses 0, 1, 2, 3, 4, 5, 6, 7 respectively.

In order to assign any IQAN-MC2 a unique address other than '0', an *ID-Tag* will have to be connected to the positions ADDR-H and ADDR-L.



Connecting of Id-Tag.

Terminating

To eliminate interference in the communications through the CAN bus, the CAN bus must be terminated. By default, the MC2 is terminated internally on all of its CAN buses. When an IQANdesign application is loaded, it can set individual buses to be non-terminated.

To give an IQAN-MC2 a unique address, you may use an addressing ID-tag, or an ID-tag having a combined address and terminating function. The 'T' values of ID-tags are ignored, i.e. an ID-tag 3T is equivalent to ID-tag 3.

If the module is located at the end of the CAN-bus, then leave the bus default terminated in the MC2.



NOTICE

The CAN-bus should not be terminated at the MC2 using an external regular terminating resistor, due to the fact that terminating is made from within the MC2 module by default.

Diagnostic interfaces

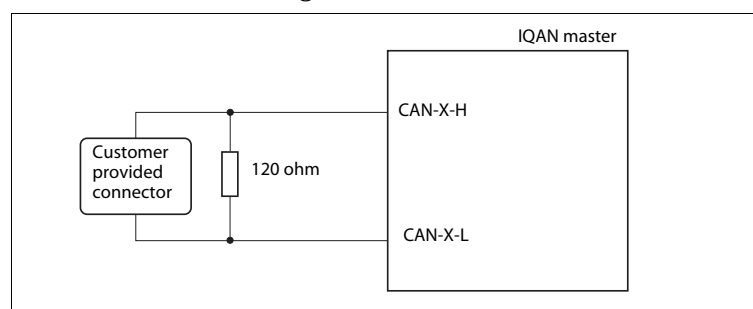
IQAN software includes many tools for tuning, measuring, accessing logs and otherwise checking the performance or troubleshooting your control system. To use the diagnostic tools with an IQAN master module you may choose between different ways to connect to the unit.

CAN diagnostics connection

One of the CAN buses of the IQAN master module may be dedicated for diagnostics. Reserving a bus for diagnostics ensures that signals are not interrupted by other bus traffic. A high-speed CAN interface is needed to use this feature. Contact Parker for information about supported CAN interfaces.

A termination resistor is usually required at the CAN interface on the PC. Parker part number 5030082 or 5030182, or an equivalent 120 ohm resistor may be used. A flying lead cable may be connected to the IQAN master to provide a connector interface. The connection from IQAN master module to diagnostic CAN interface can then be made quite easily. It is recommended that the connector be a sealed, automotive type. When not being used this connector should be protected from the environment with a cover or mating blank plug.

The recommended wiring to the IQAN master module connector is shown below.

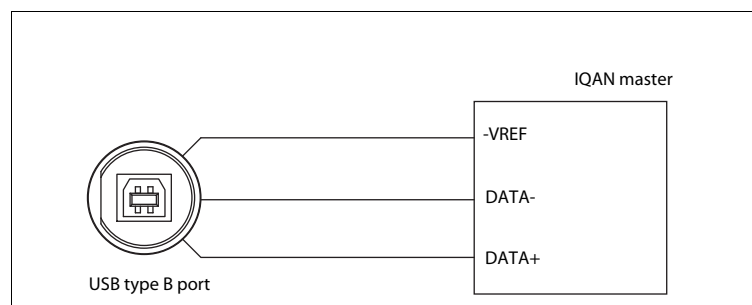


Connecting for CAN communication.

USB connection

This IQAN master module has an *USB interface* for communicating with the programming software, IQANdesign and for diagnostics. A flying lead cable, 5030124 may be connected to the master module to provide an USB type B connector interface. The connection from the module to PC can be made with a standard USB Type A male to Type B male cable.

Connection of Parker cable 5030124 is shown below.



Connecting for USB communication.



NOTICE

It is recommended that the two data wires, *DATA+* and *DATA-*, be a twisted pair, 15 twists/meter. Use *-VREF* for the ground connection as shown.

USB and "ground loops" (differences in ground potential)

When systems consisting of machines, modules, computers and other devices with different ground potentials are connected by a USB cable, a ground loop may be created. The grounds may only differ by a few millivolts, or by much more. This can be significant when compared to the low level voltage signals that are used in USB data transmission.



NOTICE

Protect the PC and unit from damage due to ground loops and surges!

Ground loops can cause problems in communicating and in extreme cases the amount of current flow can damage the USB transceiver in the PC or the module.

A recommended way to prevent ground loops is to ensure that your system includes isolation. Isolation protects your PC from damage and preserves the integrity of your data by physically separating the electrical connections between the PC and the unit.

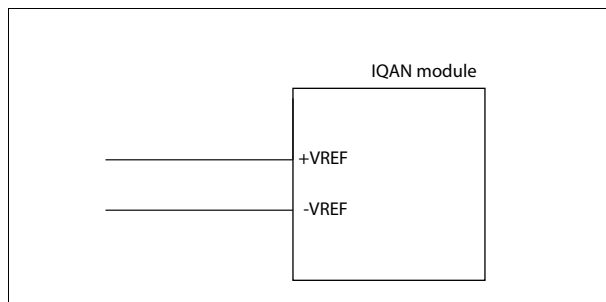
Good: Using a battery-powered laptop can prevent the formation of accidental ground loops and short circuits. This protection only holds true, however, as long as the laptop is not also connected to self-powered devices such as printers.

Better: Isolation can be provided by adding an isolated USB hub between the PC and the unit.

Best: Use a CAN-USB interface with galvanic isolation and communicate with unit via CAN bus. This setup is used in the automotive industry for diagnostics.

Reference voltage, V_{REF}

The IQAN module is internally equipped with a voltage regulator to generate the reference voltage V_{REF} . The standard reference voltage will feed different kinds of sensors and potentiometers.



V_{REF} positions.



NOTICE

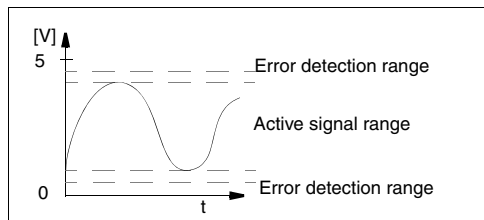
It is strongly recommended to use the module's $-V_{REF}$ and $+V_{REF}$ to all sensors and potentiometers that are connected to the module inputs. This will reduce bad measurement based on potential fault (i.e. different ground points for other supplies in relation to the IQAN module ground, -BAT).

Maximum load for the V_{REF} is different according to 12/24 Vdc power supply, see "Appendix A".

Voltage inputs

Connecting sensors to the voltage inputs

The sensor signal range must be 0-5 Vdc. To detect signal errors such as short circuits or interruptions the active signal range be within 0.5-4.5 Vdc.



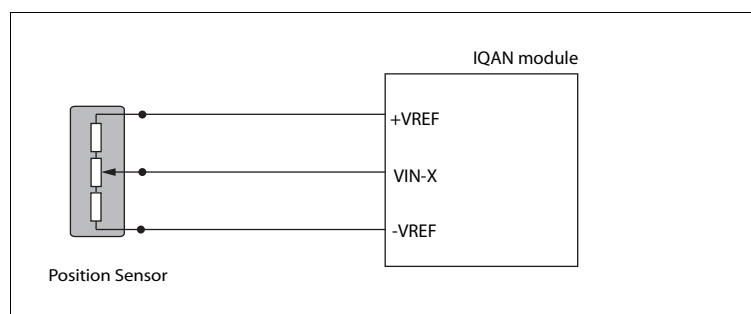
Active signal range.

The current consumption related to the voltage input is negligible.

The positive terminal of the sensor is connected to the +VREF position and the corresponding negative terminal to the -VREF position. The sensor signal is connected to appropriate VIN position.

EXAMPLE

Connect the positive and negative terminals of the position sensor to +VREF, and -VREF, respectively. Then connect the sensor signal to VIN-X.



Connecting VREF and sensor signal VIN-X.



NOTICE

The negative terminal of the sensor must not be connected to the chassis.
Maximum load for VREF position: see Appendix A.

Connecting other 3 wire sensors

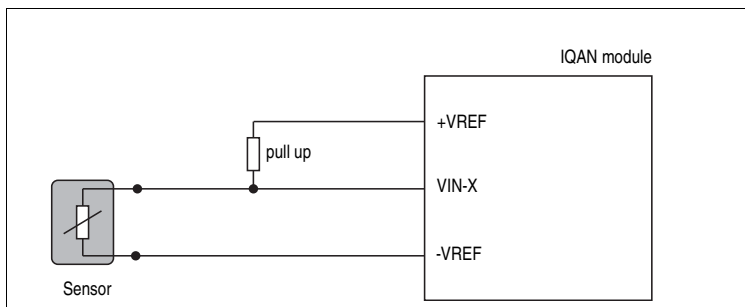
The same type of connection shown for potentiometers is used for other 3 wire sensors supplied with power from the regulated 5VDC supply, VREF. This includes active temperature sensor IQAN-ST, pressure sensor IQAN-SP and Hall-effect levers IQAN-LST or IQAN-LSL.

Connecting a 2-wire temperature sensor to voltage in

When you connect a PTC (positive temperature coefficient) temperature sensor you may need to use a pull up resistor on the input signal. Please check the technical data for your specific temperature sensor.

EXAMPLE

Connect the negative terminal of the temperature sensor to -VREF, and the signal to VIN-X. The pull up resistor will be connected between VIN-X, and +VREF.



Connecting -VREF and temperature sensor signal VIN-X.

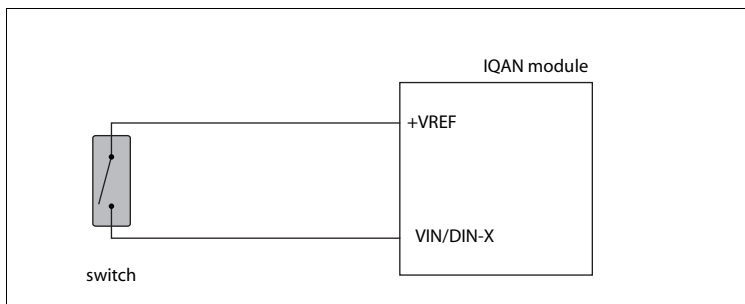
The pull up resistor value for a $R_{25}=2000\Omega$, PTC sensor is 4,7 K Ω .

Connecting switches to the voltage inputs

Switches could be connected to the voltage inputs, to create a digital on/off signal. The switches should be connected to +VREF and VIN/DIN respectively for 5V signal. The current consumption for the input is negligible.

EXAMPLE

Connect the positive and negative terminals of the switch to +VREF, and VIN-X, respectively.



Connecting a switch to VIN-X and VREF.



NOTICE

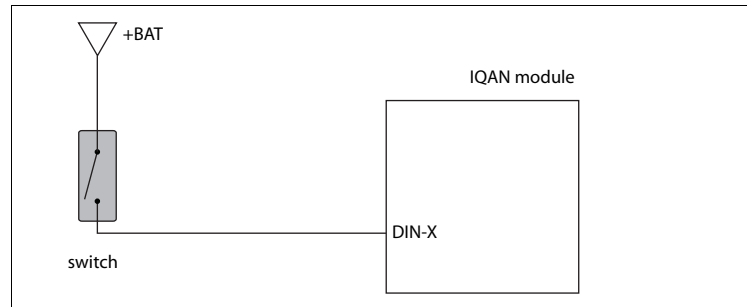
Maximum load for VREF position, see "Appendix A".

Connecting switches to the voltage inputs

It is recommended to connect system voltage +BAT to the input through a switch in order to reserve 5Vdc VREF for sensors and potentiometers.

EXAMPLE

Connect the positive and negative terminals of the switch to supply or the unit's +BAT, and DIN-X, respectively.



Connecting a switch to DIN-X and +BAT.

Digital inputs

DIN that share pins with VIN

These digital inputs share pins with the module voltage inputs and have high impedance characteristics. The preceding switch examples apply to these inputs.

DIN that share pins with CRET

These digital inputs share pins with the return pins of the proportional output channels, e.g. CRET and PWMRET. These pins have an internal power clamping diode. If used as inputs they must be connected in a way that prevents 'backending', that is, supplying power to the module from a source other than its power pin (+BAT).

Carefully read the following section for more information.

Connecting switches to the digital inputs

When connecting switches to the digital inputs, DIN, that share pins with CRET, extra precautions should be taken.



WARNING

The DIN that share pins with the CRET positions of the proportional outputs have a possibility of 'backending' the IQAN module when using those pins as digital inputs. The internal circuitry has power clamping diodes between CRET pins and the internal power supply. This arrangement creates a risk of inadvertently supplying power to the unit.

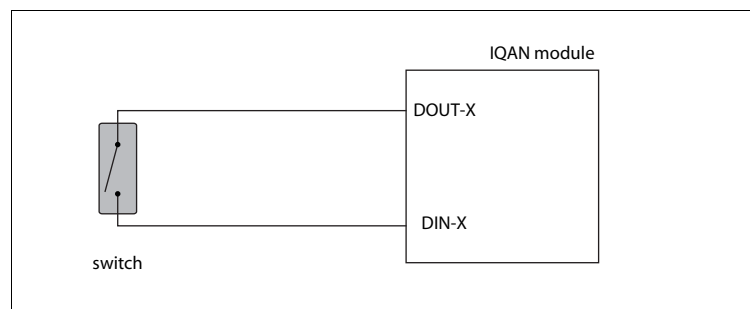
You can safely connect using +VREF for the supply, as shown in the preceding "Connecting switches to the voltage inputs" example.

If you would like to preserve +VREF for sensors and joysticks, then there are two additional methods:

- 1 The switches could be powered by one of the module's DOUT pins.

EXAMPLE

Connect the supply of the switch to DOUT-X, and the signal to DIN-X, respectively.

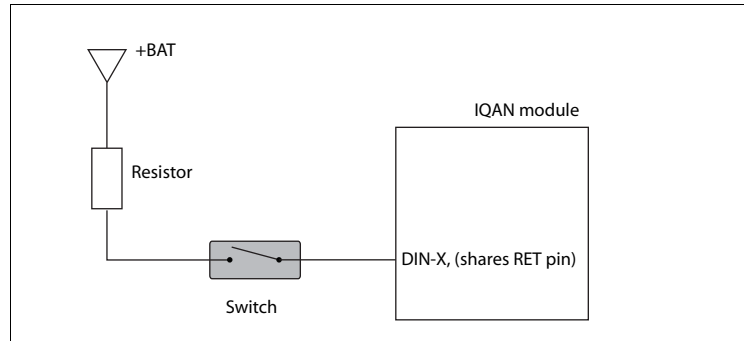


Connecting a switch to DOUT-X and DIN-X.

2 The switch supply could be connected through a high impedance resistor.

EXAMPLE

Connect the supply of the switch to +BAT through a high impedance resistor, and the signal to DIN-X , respectively.



Connecting a switch to DIN-X and supply through a resistor.



WARNING

Do not exceed 35Kohm for 12 Vdc systems and 50Kohm for 24 Vdc systems!

The DIN signal will not be detected by the module.

Remember that these flexible I/O pins must be configured in pairs of the same type, VIN, DIN or DOUT-LS.

Frequency inputs

Connecting sensors to the frequency inputs

Frequency inputs can operate in 2 modes. *Speed* which is frequency and *position* which is a pulse count. For the frequency ranges and trigger levels, see Appendix A.

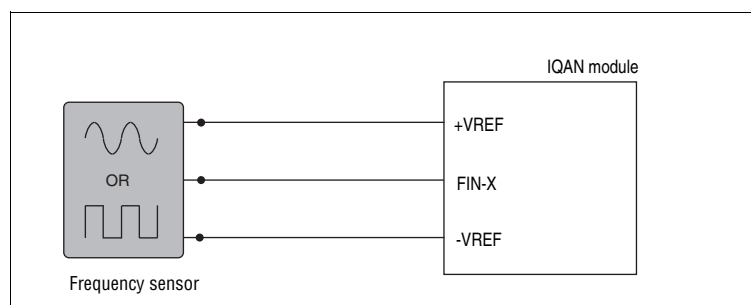
Simple frequency sensor

The positive terminal of the frequency sensor is connected to the +VREF and the negative terminal to the -VREF respectively. The sensor signal is connected to the FIN position.

If the current consumption for the sensor exceeds the maximum load for the VREF, the sensor could be connected to the +BAT/-BAT positions.

EXAMPLE

Connect the positive and negative terminals of the frequency sensor to +VREF, and -VREF, respectively. Then connect the sensor signal to FIN-X.



Connecting of frequency sensor.



NOTICE

The negative terminal of the sensor must not be connected to the chassis. Maximum load for VREF position, see Appendix A.

Proportional outputs

The current /PWM outputs control proportional valves and devices. For the current range and loads, see Appendix A.

Frequency

To obtain the best performance from proportional valves the controller produces a PWM current mode (closed loop) output signal or a PWM voltage (open loop) output signal. The type of output is selectable in IQAN software. The module has an adjustable frequency which can be changed using IQAN software. For the possible frequencies, see Appendix A.

Connecting loads to proportional outputs

Connecting a load, e.g. one proportional valve section, to the current mode or PWM mode outputs is done by using the COUT/CRET paired positions.

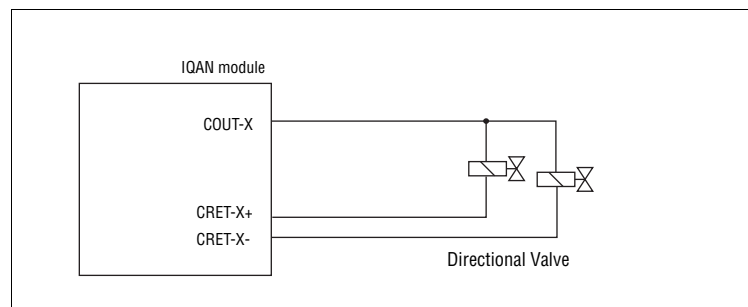
EXAMPLE

Positive direction:

Connect the proportional valve to the COUT-X, and the CRET-X+, respectively.

Negative direction:

Connect the proportional valve to the COUT-X, and the CRET-X-, respectively.



Connecting a load to a proportional output.



NOTICE

DO NOT install diodes across coils for Current or PWM modes!

Digital outputs

The digital outputs control relays and on/off valves.
For the maximum load per output see Appendix A.

Connecting loads to digital outputs

Connecting of loads to the digital outputs such as on/off valves is done by using the DOUT positions and the negative battery terminal as ground.

Protection against voltage transients

A clamping diode must be placed between the digital output and ground, as close to the load as possible. This protects the output against high voltage transients.

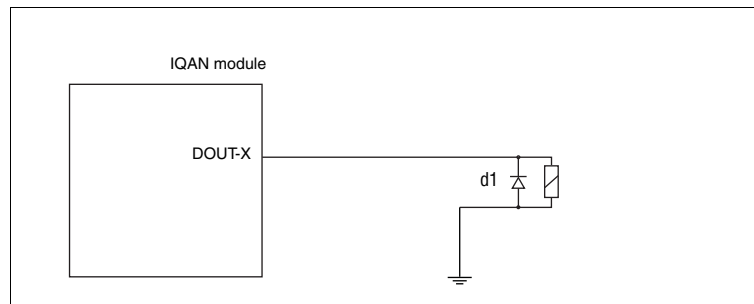
For example, use diode: 1N5408 (3A/1000V).

Depending on the load, other clamping diodes might be used instead.

EXAMPLE

Connect the on/off valve to the digital output using the DOUT-X, and the negative battery terminal as ground.

A clamping diode must be placed as close to the load as possible

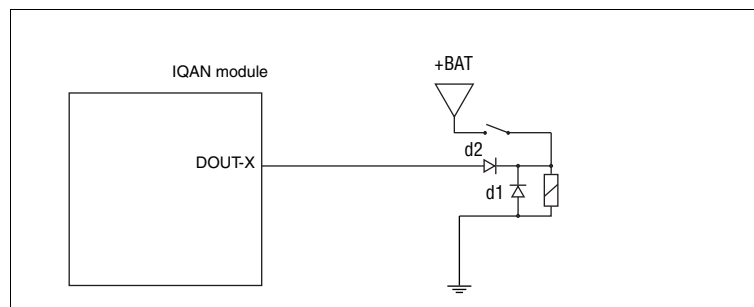


Connecting a load to the digital output.



NOTICE

If the load is controlled in parallel with another system, the digital output must be protected with a diode.



Digital output protected with a diode.

Low-side digital outputs

The low-side digital outputs may control relays and on/off valves.
For the maximum load per output see Appendix A.

Connecting loads to low-side digital outputs

Connecting of loads to the low-side digital outputs such as on/off valves is done by using the DOUT(LS) positions and one or more DOUT channels as supply.

Protection against voltage transients

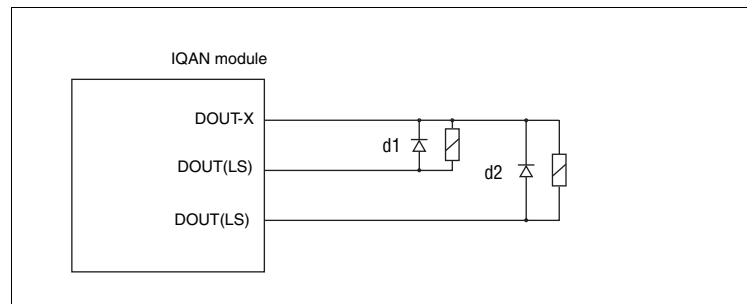
A clamping diode must be placed between the source and low-side digital output, as close to the load as possible. This protects the output against high voltage transients. For example, use diode: 1N5408 (3A/1000V).

Depending on the load, other clamping diodes might be used instead.

EXAMPLE

Connect the on/off valves to the low-side digital outputs using a pair of the DOUT(LS) positions, and the DOUT-X, as supply.

A clamping diode must be placed as close to the load as possible, see figure below.



Connecting loads to the low-side digital outputs.



WARNING

Loads on DOUT with Low-Side switch (DOUT[LS]) must always be controlled on the high-side by connection to a digital output with High-Side switch (DOUT-X) for safe function. The total sum of current supplied to the loads controlled by a number of DOUT[LS] is limited to 2000mA.

Remember that these flexible I/O pins must be configured in pairs of the same type, VIN, DIN or DOUT-LS.

7 Start-up

Start-up procedures

This chapter contains instructions for action to be taken in connection with the initial start.

**WARNING**

Risk of injury!

If the control system is not fitted properly, the machine could move uncontrollably. The machine's engine shall not be started before the control system is completely fitted and its signals are verified.

Starting the control system

Start the control system as follows:

- Prior to start, all modules and cables are to be fitted correctly.
- Check fuses, i.e. make sure that the supply voltage to the modules is equipped with the correct fuse.
- Make sure that connections for supply voltage and return lines are correct in the cable's conductor joint.
- Make sure an emergency stop is installed.
The emergency stop should disconnect the supply voltage to all modules. Alternatively, the emergency stop may also shut off the diesel engine or a dump valve, and with that, depressurize the hydraulic system.

Prepare for system start

**WARNING**

Make sure no one is in dangerous proximity to the vehicle to avoid injuries when it starts.

Prepare for the initial system start as follows:

- The engine for the hydraulic system's pump shall be in off position.
- Make sure that all connectors are properly connected.
- Turn on the control system.
- Make sure that voltage is being supplied to all modules; the power/status diode shall be illuminated on all modules. Also, make sure that the master is in contact with all modules by reading the master's display.
- Make sure the emergency stop is functioning properly.

Start the system

Start the system as follows:

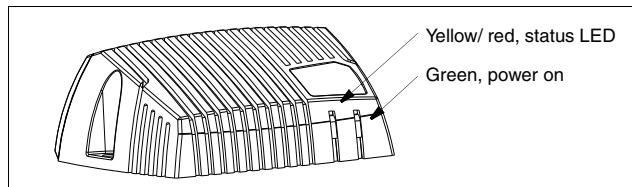
- Start the engine for the hydraulic system's pump, assuming that the above mentioned inspections have been carried out and shown correct values.

Calibrate and adjust input and output signals according to the instructions related to the master menu system and check each and every output function carefully.

8 System Diagnostics

The yellow blinking LED on the top of the module indicates normal status. If there is an error detected, the IQAN module will indicate *error status* through the red blinking LED.

This gives an immediate diagnosis as to the nature of the error that has occurred.



The location of the LED indicators on the IQAN module.

The green LED indicates power on. The yellow/red LED, will be blinking red when an error has been detected. To get further information about the error messages, see Appendix B.

Safe mode

If the ADDR_L voltage > 3.00V (ADDR_L pin shorted to ADDR_H) is detected when the module starts (during power up) the application will not be loaded. This is a special start-up mode that is used for master modules and puts the unit in a safe state without starting any application.

When 'safe mode' is desired, a jumper is put across pins 1 and 14, in place of an ID-Tag.

Appendix A

IQAN-MC2 Technical Overview

Absolute Maximum Ratings^a

Parameter	Limit values			Unit	Remark
	min.	typ.	max.		
Ambient temperature, T_A Storage temperature T_{ST}	-40 -40		+70 +100	°C	
Voltage supply on +BAT	6		36	V	Reverse polarity protected with 20A fuse.
Voltage on any pin with respect to -BAT			36	V	
Power driver load			20	A	

a.The "Absolute Maximum Ratings" table lists the maximum limits to which the device can be subjected without damage. This doesn't imply that the device will function at these extreme conditions, only that, when these conditions are removed and the device operated within the "Recommended Operating Conditions", it will still be functional and its useful life won't have been shortened.

Environmental ratings

Parameter	Remark
EMC Radiated emission Conducted emission Conducted susceptibility Radiated susceptibility Conducted transients susceptibility	ISO 13766:2010/ISO 14982:2009 EN 55025:2003, 0.15-108 MHz ISO 11452-2:1995, 20-1000 MHz ISO 11452-4:2001, 1-200 MHz ISO 7637-3:2007, Level 3 ISO 7637-2:2004, Pulse1,2a,2b,3a,3b,4,Level 3,Pulse 5,Level 1
ESD Operation Handling	ISO 10605:2001, 8 kV contact, 15 kV air ISO 10605:2001, 4 kV contact
Mechanical environment Random vibration Shock	IEC 60068-2-64:2008 Fh, 15-250 Hz, 9.7 grams, 3x10 hours IEC 60068-2-27:2008 Ea, 40 g, 6 ms, 1000*6 directions
Climate environment Enclosure, water and dust protection Enclosure, water and dust protection Salt mist Damp heat, cyclic Damp heat, steady state Heat, operation Cold Change of temperature	IEC 600529:2001, IP65 DIN 40050 Part 9:1993, IP6K9K IEC 68-2-52:1996 Kb, 72 hours IEC 60068-2-30:2005 Db, +55°C, 95% RH, 6 cycles IEC 60068-2-78:2001 Cab, +40°C, 93% RH, 21 days IEC 60068-2-2:2007 Bb, 70°C, 72 hours IEC 60068-2-1:1993 Ab, -40°C, 16 hours IEC 60068-2-14:1984 Nb, -30°C to +55°C, 10x8 hours

System

$T_A = +25\text{ °C}$ (unless otherwise specified)

Parameter	Remark
Ambient temperature, T_{ROC}	-40 to 70 °C
Voltage supply, V_{BAT}	9 to 32 V
Current supply $V_{BAT}=14V$ $V_{BAT}=28V$	typical 200 mA typical 160mA

System $T_A = +25\text{ }^{\circ}\text{C}$ (unless otherwise specified)

Parameter	Remark
Current supply RTC <i>+RTC = 14V</i> <i>+RTC = 28V</i>	typical 4 mA typical 8 mA
Start-up delay	typical 600 ms with small application
System cycle time	3 to 100 ms
Application flash memory	832 kB
Application RAM memory	832 kB
Data log memory	typical 40,000 records
CAN	
CAN specification	CAN 2.0A, CAN 2.0B
CAN speed	125 to 500 kbits
Protection	SCB, SCG
USB	
USB device	USB 1.1 full speed

VREF sensor supply

Parameter	Remark
Output voltage	5 V $\pm$ 50 mV, -40 to 70 $^{\circ}\text{C}$
Output voltage temperature drift	0.25 mV/ $^{\circ}\text{C}$, -40 to 70 $^{\circ}\text{C}$
Maximum load current	150 mA
Protection	overload, SCB, SCG
Diagnostics	under/over voltage
Under/over voltage threshold	$\pm$ 150 mV from nominal value

I/O $T_A = +25\text{ }^{\circ}\text{C}$ (unless otherwise specified)

Parameter	Remark
VIN (Voltage input)	
Full scale	5000 mV $\pm$ 100 mV
Resolution	12 bits (1.22 mV)
Input impedance	36 Kohm pull-down in parallel with 10 nF
Accuracy <i>with external sensor supply</i> <i>with VREF sensor supply</i>	$\pm$ (0.8 % + 5 mV), -40 to 70 $^{\circ}\text{C}$ $\pm$ (0.2 % + 5 mV), -40 to 70 $^{\circ}\text{C}$
Sample rate	same as system cycle time T_{SC}
Protection	SCB, SCG
Diagnostics	Defined in application

I/O $T_A = +25\text{ }^{\circ}\text{C}$ (unless otherwise specified)

Parameter	Remark
DIN (On/off input)	
Input signal low	<1 V
Input signal high	>4 V
Input hysteresis	typ. 1 V
Input impedance	36 Kohm pull-down in parallel with 10 nF
Sample rate	same as system cycle time T_{SC}
Diagnostics	Defined in application
FIN (Frequency input)/DFIN (Directional Frequency Input)	
Input signal low	<1 V
Input signal high	>4 V
Input hysteresis	>0.3 V
Input impedance	36 Kohm pull-down in parallel with 10 nF
Frequency range <i>FIN</i> <i>DFIN</i>	1 to 20,000 Hz (>20 Hz in Fast response) 1 to 20,000 Hz (>20 Hz in Fast response)
Minimum pulse width	10 μ s for 5 V signal
Step response	400 ms, 10% to 90% step
Diagnostics	defined in application
PCNT (Pulse Count)/DPCNT (Directional Pulse Count)	
Input signal low	<1 V
Input signal high	>4 V
Input hysteresis	>0.3 V
Input impedance	36 Kohm pull-down in parallel with 10 nF
Frequency range <i>PCNT</i> <i>DPCNT</i>	1 to 20,000 Hz 1 to 20,000 Hz
Minimum pulse width	10 μ s for 5 V signal
Diagnostics	defined in application
COUT (current closed-loop mode) power driver	
COUT range <i>Low</i> <i>High</i>	100 mA 2000 mA
COUT resolution	0.1 mA
Power driver voltage drop <i>750 mA</i> <i>1500 mA</i>	typ. 0.45 V @ saturation typ. 0.90 V @ saturation
Maximum COUT saturation	>50% of commanded output
Absolute accuracy	$\pm(2\% + 15\text{ mA})$, -40 to 70 $^{\circ}\text{C}$
Dither frequency, F_{DITH}	see table
Supply rejection	$\pm 2\text{ mA}$, V_{BAT} change 9 to 18V or 18 to 32V
Load rejection	$\pm 2\text{ mA}$, load change $\pm 50\%$

I/O $T_A = +25\text{ }^{\circ}\text{C}$ (unless otherwise specified)

Parameter	Remark
Maximum load $V_{BAT} = 14V$ and $F_{DITH} \geq 200\text{ Hz}$ $V_{BAT} = 14V$ and $F_{DITH} \leq 167\text{ Hz}$ $V_{BAT} = 28V$ and $F_{DITH} \geq 200\text{ Hz}$ $V_{BAT} = 28V$ and $F_{DITH} \leq 167\text{ Hz}$	5 ohm + 10 mH 5 ohm + 20 mH 10 ohm + 30 mH 20 ohm + 60 mH
Protection	overload, SCB, SCG
Diagnostics	open load, overload, saturation
PWMOUT (voltage open-loop mode) power driver	
PWMOUT range	0% to 95%
PWMOUT resolution	0.1 %
Dither frequency, F_{DITH}	see table
Power driver voltage drop	typ. 0.9 V @ 1.5 A load
Maximum load	2 A
Maximum allowable load inductance 1.0 A 1.5 A	500 mH 200 mH
Protection	overload, SCB, SCG
Diagnostics	none
Overload threshold	typ. 2.5 A
DOUT (on/off output) power driver	
Maximum load <i>DOUT-A to DOUT-H (high side)</i> <i>DOUT-I to DOUT-X (low side)</i>	2 A 2 A
Power driver voltage drop <i>DOUT-A to DOUT-H (high side)</i> <i>DOUT-I to DOUT-X (low side)</i>	typ. 0.3V @ 1.5 A load typ. 0.6V @ 1.5 A load
Leakage current in off-state <i>DOUT-A to DOUT-H (high side)</i> <i>DOUT-I to DOUT-X (low side)</i>	< 100 uA typ. 0.1 mA
Maximum allowable load inductance 1.0 A 1.5 A	500 mH 200 mH
Protection <i>Overload threshold (high side)</i> <i>Overload threshold (low side)</i>	typ. 2.5 A typ. 5 A
Diagnostics <i>DOUT-A to DOUT-H (high side)</i> <i>DOUT-I to DOUT-X (low side)</i>	none none

Frequency

The table below shows the PWM frequency possibilities. Any frequency may be entered in your application and is translated according to this table. The bold values are the actual frequencies in Hz output by the module for proportional valve control.

Frequency (Hz) entered in appl.	Frequency (Hz) out- put by module
25	25
26	26

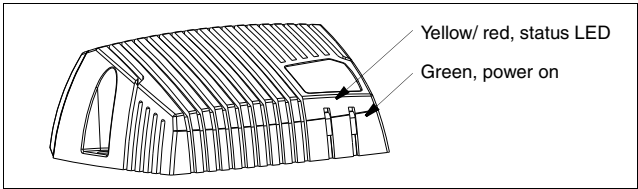
Appendix A

Frequency (Hz) entered in appl.	Frequency (Hz) out- put by module
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34-35	34
36	36
37	37
38-39	38
40-41	40
42	42
43-44	43
45-47	45
48-49	48
50-52	50
53-55	53
56-58	56
59-62	59
63-66	63
67-70	67
71-76	71
77-82	77
83-90	83
91-99	91
100-110	100
111-124	111
125-142	125
143-166	143
167-199	167
200-249	200
250-332	250
333+	333

Appendix B

Error codes, messages and actions

If one of the following error is detected, a message will be presented with an error code on the module. In some cases, the module will turn off or at least shut down the outputs, to increase safety.



The location of the LED indicators on the IQAN-MC2 module.



WARNING

Don't use the machine if an error message or error code is activated.

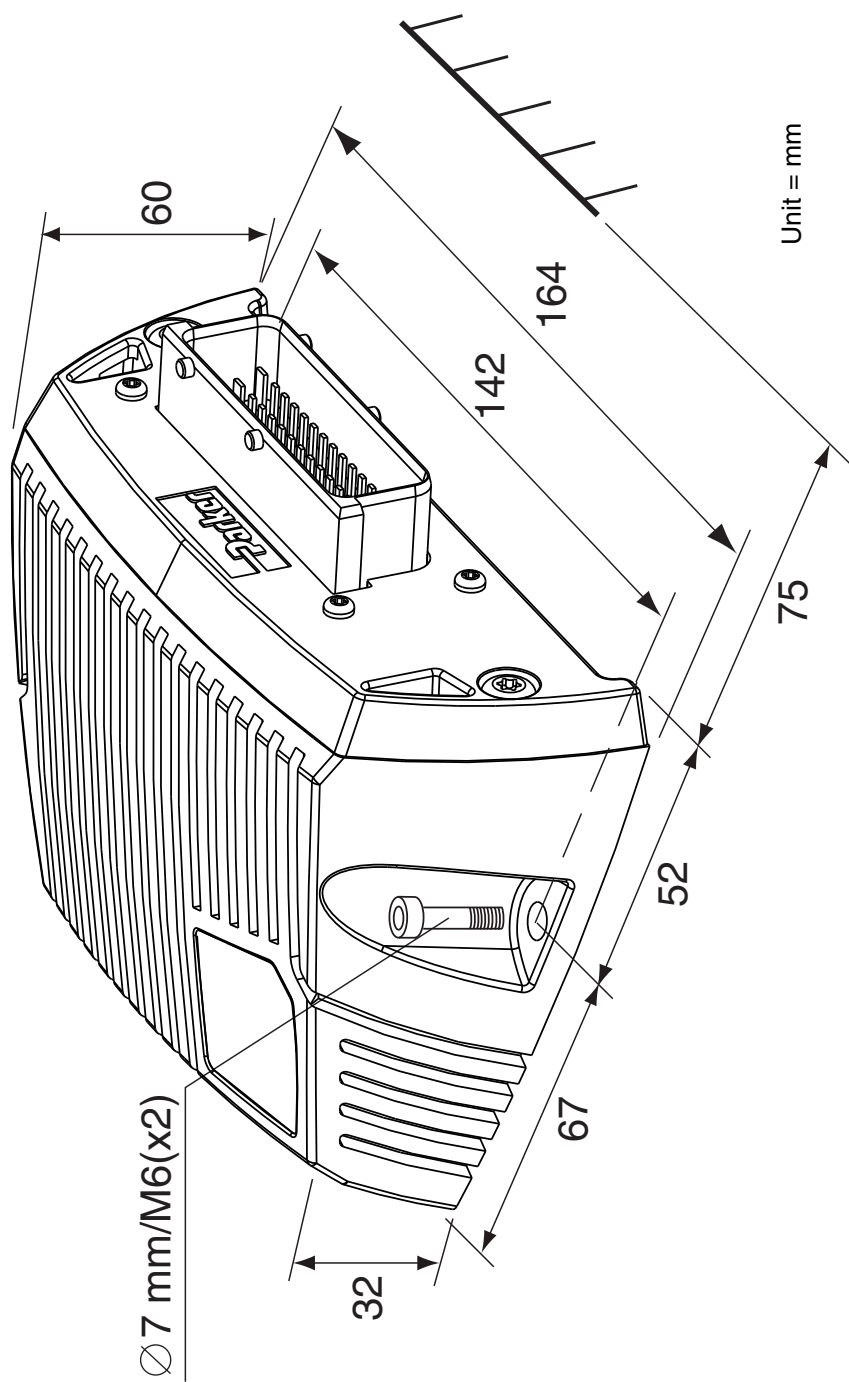
LED indicator showing different MC2 modes

Status	Flash (yellow)
Normal operation	
Application not loaded	
No application available	
Waiting for restart	

Error code	Error	Primary Flash (red) Error category	Secondary Flash (yellow) Error description
1:1	Output		
1:2	Input		
1:3	VREF		
2:1	Power supply		
2:2	Temperature		
2:3	Clock		
3:1	CAN error/No contact		
3:2	IDtag error		
3:3	System mismatch		
4:1	Internal error/OSE		

Appendix C

Dimensioning of the IQAN module



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